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Looking Forward to the Future: Impoverished Vividness for Positive Prospective Events Characterises Low Mood in Adolescence

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Running head: IMPOVERISED POSITIVE MENTAL IMAGERY IN ADOLESCENT DEPRESSION

Abstract

Background: Enhancing positive future imagery offers promise for treatment innovation in adult depression but has been neglected in adolescence. While negative life events are linked with depression-onset in adolescence, mechanisms underlying this association are poorly understood. We investigate whether difficulties in generating vivid positive future imagery characterise depression, compared to anxiety, and examine potential moderation of the relationship between negative life events and depressive symptoms in adolescence. Method: Three hundred and seventy-five young people (11-16 years) completed the Prospective Imagery Task, and self-reported on symptoms of anxiety and depression. They were also asked to describe a past negative life event they had been thinking about or imagining over the last seven days, which was subsequently coded by a clinician over whether it was no, low, moderate or high impact. Results: Symptoms of depression were associated with less vivid positive imagery and more vivid negative imagery whether past or future, whilst symptoms of anxiety were associated with increased vividness for past negative events only. The relationship between life event severity and depression was increased for those with poorer vividness for positive future events. Limitations: These data were collected at a single time-point only, limiting conclusions on temporal relationships. All measures were also self-reported, increasing shared method variance. Conclusions: These findings suggest that the relationship between negative life events and prospective positive imagery are specific to depressive symptoms in adolescence and provide foundations for novel approaches to strengthen psychological interventions.

Keywords: Adolescence; Depression; Mental imagery; Prospection; Anxiety

Introduction

Adolescent depression is common and distressing. Moreover, when depression begins in adolescence rather than adulthood, more severe social and psychological outcomes are reported, as well as higher economic costs (Suhrcke, Pillas, & Selai, 2008). Although preferred to pharmacological intervention (van Schaik et al., 2004), psychological interventions fail to consistently show sustained symptom improvement in adolescence (Weisz, McCarty, & Valeri, 2006). Long-standing cognitive treatment models for depression target negative information-processing biases in either current situations or past events. However, in adults, targeting potential deficits in processing positive information, in particular positive future-directed cognitions, may also be crucial (Holmes, Lang, Moulds, & Steele, 2008). Investigating the role of positive prospective cognitions in maintaining and treating adolescent depression has been limited. This is despite adolescence being associated with increased depression onset, less effective treatments, and a time when cognitive factors first become stably linked to depression symptoms. Here, we address this gap by investigating whether low mood is linked to differences in how young people imagine their future.

Defined as the image individuals have about their future, future orientation aids planning and goal-setting (Seginer, 2008), and an ability to imagine positive future events more vividly is associated with optimism (Blackwell et al., 2013; Ji, Holmes, & Blackwell, 2017). Optimism may protect against the development of depression (Giltay, Zitman, & Kromhout, 2006; Sharot, Riccardi, Raio, & Phelps, 2007) and enhance recovery from depression (Kronström et al., 2010). Research in adult community samples has generally demonstrated an association between less vivid *positive* future imagery and depressive symptoms, compared to more vivid *negative* future imagery and anxiety (for review, see Holmes, Blackwell, Heyes, Renner, & Raes, 2016). Such findings of valence-specificity are

consistent with the Tripartite Model, which predicts that depression is uniquely associated with an absence of positive mood and related cognitions, while its co-occurrence with anxiety arises from negative affect. However, the relationship between negative future imagery and depression is less clear. Some studies suggest that depression scores do not correlate with vividness of negative future imagery (Stober, 2000) and that there is no difference between participants with depression and control participants in how vividly they imagine negative future events (Morina, Deeprose, Pusowski, Schmid, & Holmes, 2011). In contrast, others do find a relationship (Holmes et al., 2008; Szollosi, Pajkossy, & Racsmány, 2015; Weßlau, Cloos, Höfling, & Steil, 2015) including, intrusive future images of suicide reported in depression and associated with suicidal ideation (Hales, Deeprose, Goodwin, & Holmes, 2011; Holmes, Crane, Fennell, & Williams, 2007).

There is a small yet growing body of research investigating the role of positive emotion and the positive affect system in adolescent depression (Olino, 2016). Initial data from experimental investigations have suggested that generation of positive images can increase positive affect and reduce negative interpretation bias amongst healthy adolescents (Burnett Heyes et al., 2017). Only one study has explored past and future event cognitions in adolescents (Miles, MacLeod, & Pote, 2004). Participants from the community listed positive or negative events during three past and three future time periods. Depression and anxiety were associated with generating more negative events, but not positive, contradicting findings in adults. A strength of this study was the inclusion of past and future time periods. However, their methodology did not include image generation, which is more emotionally evocative than words (Holmes & Mathews, 2010). Moreover, the measures did not consider the quality and detail of the events, which are specific features of imagery linked to depression (and anxiety) in adults.

Given that a lack of positive future imagery may be involved in depression, there remain questions over how it influences symptom onset. There is already some experimental evidence from adult community and dysphoric samples that positive imagery could protect against depression. Engaging in positive imagery [compared to verbal processing (Holmes, Lang, & Shah, 2009) or negative or mixed valence imagery (Pictet, Coughtrey, Mathews, & Holmes, 2011)] improved positive mood and positive interpretation bias as well as protected against subsequent negative mood induction (Holmes et al., 2009) or led to greater goal directed behaviour (Pictet et al., 2011). In another study with participants with depression, one week of generating daily imagery of positive scenarios (compared to listening to them) decreased depressive symptoms and negative interpretive bias (Torkan et al., 2014).

One possibility is that a lack of positive imagery interacts with negative life events to contribute to depression. Extant research suggests that negative life events are a particularly powerful risk factor for developing depression (Goodyer, Herbert, Tamplin, & Altham, 2000). In the face of a negative life event, having less vivid positive mental imagery may further reduce mood, increase hopelessness and limit the person's repertoire of emotional regulation strategies. Positive future mental imagery may also promote optimism and positive affect following a negative life event. Optimism has been associated with both resilience to a variety of stressors (Carver, Scheier, & Segerstrom, 2010) and vividness of positive future imagery (Blackwell et al., 2013), with recent data demonstrating that vividness of positive mental imagery is longitudinally associated with current and future optimism (Ji et al., 2017). Positive future imagery may also improve emotional regulation, and so likely to enhance coping with stressful events (Fredrickson & Joiner, 2002). For example, a cross-sectional study found that an individual's positive emotional response to picture stimuli is greater for those with more vivid positive imagery (Wilson, Schwannauer, Mclaughlin, Ashworth, &

Chan, 2017). If vividness of positive imagery does moderate the relationship between life events and low mood, it is likely to be readily amenable to psychological intervention.

Here, we first tested the hypothesis that vivid positive (but not negative) mental imagery (past and future) was positively associated with adolescent depressive symptomatology. Secondly, we explored whether the relationship between life event severity and depressive symptomatology was moderated by the young person's ability to vividly imagine positive events, such that the relationship between life event severity and depression is enhanced in young people with poorer prospective positive imagery ability. We used an unselected sample with varying depression levels to address these questions. Data from this study would also inform whether the Prospective Imagery Task was an appropriate measure for a youth sample. Measuring mental imagery for past events allows us to identify whether young people with symptoms of depression have less vivid mental imagery for events in general (past and future), or for positive future events only. This is important as theorists propose that retrieval of past memories influences the creation of future scenarios (Miloyan, Pachana, & Suddendorf, 2014). This study also advances existing adult studies by using a clinician-rated measure of the severity of a negative life event, rather than a simple count of events. While our suppositions were based directly on work in adults with depression, we also further explored the specificity of these associations by including anxiety. Consistent with the tripartite model (Clark & Watson, 1991), we tested whether positive future imagery was related to symptoms of depression only, whilst negative future imagery was associated with depression *and* anxiety. Elucidating whether these information-processing biases are disorder-specific or trans-diagnostic is significant for developing treatments that can more effectively modify unique clinical characteristics. This seems vital given that recent studies suggest no clear evidence to recommend a particular psychological intervention for adolescent depression (Weisz et al., 2006), whilst cognitive behavioural interventions clearly

show an advantage over active control treatments for anxiety (Reynolds, Wilson, Austin, & Hooper, 2012).

Materials and Methods

Participants

Participants were recruited from a mixed-gender secondary school in Oxfordshire, England. 375 participants (54.1% female; age: $\bar{x}$=13.69; SD=1.30; 90% White British; range 11–16) completed the study in classroom settings. The Psychiatry, Nursing and Midwifery Research Ethics Committee at Kings College London gave approval for the study (REC Reference Number: PNM/13/14-157). Participants and their parents/guardians were provided with the information sheet the week prior to participation. This included the researcher's details, who they were invited to contact if they had any queries or questions. An opt-out parental consent procedure was used. Participants completed a consent procedure on the day of testing and were given the opportunity to ask the researcher (and/or teachers) questions.

Measures

Severity of negative life event and rating validation

Young people were asked to describe a past negative life event they had been *thinking about or imagining* over the last seven days. The event could have occurred at any time and this criterion was used to identify a life event that was currently salient to the young person, this time frame is commonly used in the PTSD literature (Perrin, Meiser-Stedman, & Smith, 2005). Classifications from previous studies (Meiser-Stedman, Dalgleish, Yule, & Smith, 2012) were used to provide impact and severity ratings. Events were categorised by a clinician (VP, clinical psychologist) and co-rated by a trained postgraduate student with high inter-rater reliability (93% agreement; κ=.89, p <.0001). Events were rated as "*high impact/severity"* if the event met DSM-V criterion A for PTSD; "*moderate impact/severity"*

if the event met a previously established definition as being likely to have a significant psychological impact ("social experiences with definable onset and circumscribed course, the effects of which can be judged to have a psychological impact on an individual"); "*low impact/severity*" if the event was negative but seemed unlikely to have significant psychological impact; or "*no impact/severity"* if participants reported that they could not think of a negative event.

Clinician-ratings were validated by investigating whether child-reported intrusive images and post-traumatic stress symptoms (PTSS) significantly varied across the categories. The thirteen-item child version of the Revised Impact of Event Scale: child version (RIES-C) was administered to measure PTSS in reference to the negative event that they had previously specified. The RIES-C has been established as a good screen for PTSD diagnosis with good internal reliability (Cronbach's α=.80). Similarly, the internal consistency was good in the current study (Cronbach's α=.88). The RIES-C also includes an item that measures the frequency of intrusive *images* ("Do pictures about it pop into your mind?").

Measures of depression and anxiety

The Child Depression Inventory (CDI; Kovacs, 1981) was used to measure symptoms of depression. The CDI has been extensively validated and has good psychometric properties in nonclinical samples (Craighead, Smucker, & Ilardi, 1998). Anxiety was measured using the Screen for Childhood Anxiety Related Emotional Disorders (SCARED; Birmaher et al., 1997), which shows excellent internal consistency, test re-test reliability, and concurrent and discriminate validity (Birmaher et al., 1997). The internal consistency of both scales was excellent in this study (Cronbach's α: CDI=.90; SCARED=.94).

Mental imagery

The Prospective Imagery Task (PIT; based on Holmes et al., 2008) was adapted for young people and to include past scenarios. The past and future scales were administered separately with a break in between. For each scale, participants were asked to read fourteen scenarios, imagine each happening to them and then rate their generated mental image on a five-point scale (from **'**No image at all' to 'Very clear and detailed'). Both past and future scales included seven negative and seven positive scenarios, making four subscales. Examples of the scenarios are: "A time when you had done well at school" (positive past); "A time when you felt that people found you dull or boring" (negative past); "You will have lots of energy and enthusiasm" (positive future); and "You will feel that people don't understand you" (negative future). The scales demonstrated acceptable to good internal consistency (Cronbach's α for positive past=.77; negative past=.72; positive future=.74; negative future=.83).

Data Analysis

Firstly, we investigated whether intrusion frequency, PTSS, depression, or anxiety symptomatology varied across categories of life event severity using Chi-squared analysis for intrusion frequency; a one-way ANOVA for PTSS and a MANOVA for depression and anxiety symptoms. For all analyses, life event severity was the group variable, and the symptomatology measure the dependent variable. Univariate ANOVAs and Bonferroni corrected post-hoc comparisons were used to follow-up significant findings.

To investigate the relationship between the vividness of mental imagery and depression, hierarchical regression was performed separately for past and future imagery ratings. Depression score was entered as the dependent variable with gender, age, anxiety and life event severity as the independent variables in the first step; and the imagery ratings (positive past and negative past *or* positive future and negative future) in the second step. Next, we explored whether positive mental imagery (for past or future events) moderated the

relationship between life event severity and depression, following previous guidelines (Baron & Kenny, 1986) and studies (e.g. Lewin et al., 2006; Lewin et al., 2011). Continuous variables were mean-centred and the product of the two-predictor variables entered into the third step to represent their interaction. This 3-step hierarchical regression was repeated with anxiety as the dependent variable and depression score replacing anxiety in the first step. In the third step, negative mental imagery was investigated as a moderator. Although we chose to investigate interactions using regressions to be consistent with prior stages of the analysis examining main effects of imagery variables on dependent variables, we also replicated the moderation analysis using the PROCESS macro (Hayes, 2013; Hayes & Rockwood, 2017), which revealed the same pattern of results. Use of ordinal data as a predictor variable (i.e. life event severity) is sometimes considered problematic in regression analysis. However, it is thought to be appropriate when interpreted cautiously and can be treated as continuous even if spacing is not equivalent (Pasta, 2009; Winship & Mare, 1984), which is the approach taken by previous papers (Meiser-Stedman et al., 2012). Furthermore, moderation analyses were replicated in PROCESS with life event severity coded as a binary variable (by combining the no and low impact/severity groups, and the moderate and high impact/severity groups).

Prior to analysis, data were inspected for outliers (more than three standard deviations above the mean) and outliers were removed. Six participants were removed as they had scores three standard deviations above the mean on the CDI (one of these participants also scored three standard deviations above the mean on the SCARED). Missing data that comprised less than 10% of the total number of values on each subscale were replaced with that participant's average score on items within that subscale. Two participants had missing data (more than 10% of items) for the depression measure and one for anxiety score, and so were excluded from these analyses. A two-tailed significance level of $\alpha=0.05$ was used

throughout. For data that did not meet distributional assumptions, bootstrapping[1] was used for inference. All statistical analysis was performed in IBM SPSS Statistics, version 24.0 (Arbuckle, 2016).

Results

Life Event Severity and Symptoms of Post-traumatic Stress, Depression and Anxiety

The following classifications were given to the reported negative events: 19 (5.1%) were categorised as *high impact/severity* (e.g. car accident); 116 (31.4%) as having *moderate impact/severity* (e.g. the death of a family member; parental divorce); 204 (55.3%) as a *low impact/severity* (e.g. argument with friends; failing an exam); and 30 (8.1%) as *no impact/severity*. Levels of depression ($\bar{x}$=7.68, SD=5.99 on the 26 item measure) and anxiety ($\bar{x}$=21.69, SD=14.11), as well as the proportion of those scoring above recommended clinical cut-offs (depression: n=44, 11.9%; anxiety: n=128, 34.7%), were consistent with previous research (Craighead et al., 1998; Muris et al., 1998).

Only participants who identified an event that was coded as high, moderate or low impact/severity (n=339) completed the measure of PTSS and were included in the following analysis (see table 1 for descriptive statistics). A significant difference in the frequency of intrusive pictures of the event across event severities was found ($\chi^2(6) = 21.68$, $p = 0.001$, Cramer's V = 0.18), with more severe events being associated with more frequent intrusive images. Follow-up analysis revealed significant differences between those participants who had experienced an event rated as *high impact/severity* compared to those who had experienced an event rated as *low impact/severity* $\chi^2(3) = 14.84$, $p = 0.002$, Cramer's V =

[1] Bootstrapping is a computer-intensive, non-parametric approach to statistical inference that provides valid standard errors, confidence intervals and p values for hypothesis tests. It only assumes that the sampled data provide a reasonable representation of the population from which they came and therefore do not have to meet distributional assumptions.

0.26) and *moderate impact*/severity $\chi^2(3) = 10.93$, $p = 0.012$, Cramer's V = 0.29), but not between *moderate impact/severity and low impact/severity* $\chi^2(3) = 7.05$, $p = 0.070$).

Similarly, a one-way ANOVA revealed that young people reported more PTSS if they had experienced a more severe event, $F(2,338) = 7.63$, p = 0.001, $\eta_p^2 = .043$. Post-hoc t-tests illustrated that those who had experienced an event that was rated as *low impact/severity* were less likely to experience PTSS compared to those whose event was rated *moderate impact/severity* ($t(318) = 3.28$, $p = 0.001$, 95% CI = -8.70 to -2.18, $r = 0.18$) or as *high impact/severity* ($t(221) = 2.62$, $p = 0.009$, 95% CI = -16.15 to -2.29, $r = 0.17$). There was no significant difference between the *moderate impact/severity* and *high impact/severity* groups ($t(133) = -1.10$, $p = 0.28$, 95% CI = -10.60 to 3.04).

The MANOVA with event severity as the group variable and depression and anxiety symptomatology as dependent variables for the full sample revealed, using Pillai's trace, a significant effect of group on the dependent variables, V=0.070, $F(6,724) = 4.40$, $p < 0.0001$, $\eta_p^2 = .035$ (see table 1). Separate univariate ANOVAs confirmed these group differences for depression, $F(3,363) = 8.08$, $p < 0.0001$, η_p^2=.063, and anxiety, $F(3, 364) = 5.29$, $p = 0.001$, $\eta_p^2 = 0.042$). More severe events were associated with more depression and anxiety symptoms. Bonferroni corrected post-hoc comparisons revealed significant differences in depression between *no impact/severity* group and the group reporting events with *high impact/severity* ($t(46) = 3.54$, $p = 0.001$, 95% CI = 10.48 to -2.88; $r = 0.25$); and *moderate impact/severity* ($t(144) = 3.19$, $p = 0.002$, 95% CI = -6.41 to -1.51, $r = 0.14$); but not *low impact/severity* ($t(231) = 1.80$, $p = 0.073$, 95% CI = -3.92 to 0.17). For anxiety, there was a significant difference between the *no impact/severity* and *high impact/severity* groups ($t(47) = 2.83$, $p = 0.007$, 95% CI = -21.29 to -3.60, $r = 0.20$) but not the other two groups (life event with *moderate impact/severity* $t(144) = 2.09$, $p = 0.038$, 95% CI = -12.79 to -.36; *low*

impact/severity: $t(231) = 1.01$, $p = 0.31$, 0.05, 95% CI = -7.40 to 2.38). [Of note, the same pattern of results is observed when the outliers are included].

[INSERT TABLE 1]

Relationship between Vividness of Mental Imagery and Depression and Anxiety

Vividness ratings for positive past and future imagery were strongly correlated as were negative past and future imagery (see table 2). However, there was no significant association between the other vividness ratings. Separate regressions with past and future imagery were run for depression versus anxiety symptomatology.

[INSERT TABLE 2]

Depressive symptomatology

The first step was identical for both regressions. Step 1 was significant ($F(4,365) = 47.42$, $p < 0.0001$, $R^2=.34$) with gender, anxiety and event severity all predicting depression score. Step 2 was significant for both regressions (past imagery: $F(6,365) = 59.18$, $p < 0.0001$, $R^2 = .50$ $\Delta R^2=0.15$, $p < 0.0001$; future imagery $F(6,365) = 58.42$, $p < 0.0001$, $R^2 =.49$, $\Delta R^2 = 0.15$, $p < 0.0001$) with all four mental imagery subscales predicting depression (see table 3 for full analysis).

The third step of the model included an interaction term between event severity and positive past mental imagery in the first regression, and then between event severity and positive future mental imagery in the second regression. The third step was not significant for positive past ($F(7,365) = 51.50$, $p < 0.0001$, $R^2 = .50$, $\Delta R^2 = 0.005$, $p = 0.073$) but was significant for positive future mental imagery ($F(7,365) = 51.70$, $p < 0.0001$, $R^2=.50$, $\Delta R^2=0.009$, $p = 0.013$). This indicates that positive future imagery moderated the relationship between event severity and depression. Importantly, when negative past and negative future imagery were separately investigated as moderators, they were non-significant. Of note, the same pattern of results is found when anxiety is not included as a covariate and when outliers

are included in the analysis. The same pattern of results is also observed when life events are coded as a binary variable ($F(6,359) = 44.69$, $p < 0.0001$, $R^2=.43$, $\Delta R^2=0.0085$, $p = 0.022$).

[INSERT TABLE 3]

Anxiety

The above analysis was repeated with anxiety score as the dependent variable. Step 1 was again significant for both regressions ($F(4, 365) = 56.35$, $p < 0.0001$, $R^2 = .38$) with anxiety score being predicted by gender and depression score in step 1. Step 2 was significant when the past imagery variables were included ($F(6, 365) = 42.75$, $p < 0.0001$, $R^2 = .42$, $\Delta R^2 = 0.032$, $p < 0.0001$), and not when the future imagery variables were included ($F(6, 365) = 38.55$, $p < 0.0001$, $R^2 = .39$, $\Delta R^2 = 0.007$, $p =0.11$). Of the imagery variables, negative past imagery was the only significant predictor of anxiety (Table 4).

The third step of the regression was significant *(*$F(7, 365) = 37.56$, $p < 0.0001$, $R^2=.42$, $\Delta R^2=0.007$, $p = 0.043$) indicating that negative past imagery significantly moderated the relationship between anxiety and event severity. However, the bootstrapped p-value for the interaction variable was not significant (p=.078) and so this finding needs to be interpreted with caution. We did not investigate the other subscales further as they were non-significant in step 2. Of note, the same pattern of results is observed when the outliers are included. The same pattern of results is also observed when life events are coded as a binary variable ($F(6,359) = 43.34$, $p < 0.0001$, $R^2=.42$, $\Delta R^2=0.0044$, $p = 0.0998$).

[INSERT TABLE 4]

Discussion

This study investigated the relationship between mental imagery of positive and negative events (past and future), and depression and anxiety. We expanded previous work in various ways. Firstly, extending adult studies to an adolescent population, these results suggest that depressive symptomatology was linked to having *more* vivid imagery for

negative events and *less* vivid imagery for positive events across the past and future. In contrast, mental imagery for past negative events, in particular, is associated with anxiety. Secondly, we found initial evidence that vividness of mental imagery for positive future events may moderate the relationship between event severity and depressive symptomatology, where having less vivid positive future imagery magnified the relationship between life event severity and depressive symptomatology. More generally, we replicated previous work that severity of life events is positively associated with symptoms of post-traumatic stress, anxiety and depression. Finally, this study is the first to use the Prospective Imagery Task in adolescents and indicates that, with minor modification, it can be used to assess depression and anxiety-related cognitive differences in a younger population.

Our findings are consistent with the tripartite model (Clark & Watson, 1991) which proposes that depression and anxiety are linked to increased negative cognitions, but depression alone is associated with decreased positive cognitions. Work in adults has consistently found an association between impoverished positive imagery and depression and enhanced negative imagery and anxiety with the relationship between anxiety and positive imagery or depression and negative imagery, more mixed (Holmes et al., 2008; Morina et al., 2011; Stober, 2000). Our results broadly confirm these findings for an adolescent sample. As our data are cross-sectional, we cannot determine the direction of the relationship, i.e. whether a lack of vividness of positive imagery/increased vividness of negative imagery leads to depressive symptoms or whether depressive symptoms result in changes in imagery vividness. Experimental and longitudinal studies that can examine the direction of these relationships would be valuable.

Our second set of findings suggest that a lack of positive future imagery, in particular, may have a key role in adjusting the impact and consequences of negative events (i.e. whether the young person experiences symptoms of depression). This again appeared to be

specific to depression given that the relationship between event severity and anxiety may be moderated by negative past imagery (although this finding requires replication, given that the bootstrapped p-value was non-significant). In terms of potential mechanisms, there are several possibilities through which vivid positive mental imagery may act to reduce depression following negative life events, including optimism and augmenting positive affect. Positive vivid future imagery seems likely to promote optimism (Ji et al., 2017) and optimism buffers against the impact of a variety of stressors (Carver & Scheier, 2014) and reduces risk for depression (Giltay et al., 2006; Sharot et al., 2007). Individuals with more vivid positive future imagery also experience more positive affect, generally, as well as in response to stimuli (Fredrickson & Joiner, 2002; Wilson et al., 2017). This could protect against the impact of the negative life event and improve emotional regulation, so reducing risk for depression. Whether these mechanisms explain the observed relationship and whether they operate in combination or not requires further investigation, ideally in studies that are prospective in nature. Furthermore, the direction of the relationship could be the reverse, whereby depression leads to reductions in vividness of future positive imagery. Replication and extension of these findings are needed, ideally in studies that can determine the direction of the relationship.

An exciting implication of these findings (if replicated) is that having more vivid positive future images could protect young people against developing long-lasting depression, particularly following negative life events. As adolescence is a period when future orientation increases (Seginer, 2008), it may be a particularly important time to boost positive cognitive processing. For example, by facilitating the generation and elaboration of prospective positive imagery (Holmes, Blackwell, Heyes, Renner, & Raes, 2016). Initial data from psychological therapy trials in adults indicates that interventions aiming to enhance positive affect may be as effective as cognitive behavioural therapy in reducing depression

(Chaves, Lopez-Gomez, Hervas, & Vazquez, 2017) and imagery techniques are being explored to generate detailed positive future images (Pile et al., under review). Another technique to enhance positive imagery is imagery cognitive bias modification which involves repeated practice in generating positive mental imagery to ambiguous stimuli, however there has been limited research as yet and results are mixed (Blackwell et al., 2015; Burnett Heyes et al., 2017; Torkan et al., 2014).Targeting negative imagery may also be helpful in treating anxiety and depression. Therapeutic techniques used to address negative imagery include imaginal exposure (for example as used in Cognitive Therapy for post-traumatic stress disorder; Ehlers & Clark, 2008) and imagery rescripting. Imagery rescripting aims to modify the content of negative imagery and rescript the negative beliefs associated to be something more benign or positive. Although this research is at an early stage, promising results have been indicated (for meta-anlysis, see Morina, Lancee, & Arntz, 2017). Experimental studies also indicate that verbally updating negative images reduces intrusions and PTSS (V. Pile, Barnhofer, & Wild, 2015). Furthermore, our findings support Roepke & Seligman (2016) suggestion that helping people to spot and change dysfunctional future simulations could promote recovery and resilience.

This study has limitations. Firstly, symptoms were assessed in a nonclinical sample, which reduces generalizability to those who meet criteria for diagnoses and are seeking treatments. There are, however, advantages to using non-clinical samples for investigating cognitive factors, such as reducing the impact that current depression or treatment might have on cognitive style. Furthermore, depressive symptoms in adolescence have been shown to strongly predict major depression in adulthood (Pine, Cohen, Cohen, & Brook, 1999), identifying them as a valid group to investigate our hypotheses and to identify treatment targets for early intervention. Secondly, we relied on young people to self-report the vividness of their images, which assumes insight into these processes. Although this ensured

our methodology was consistent with previous adult studies, future studies would benefit from including an experimental measure or clinical interview. As the PIT asks participants to rate the vividness of the image generated to scenarios, we also do not know the content of the generated images. Consistent with the cognitive model, investigation of the themes may help to differentiate depressive symptomatology (e.g., themes of failure) from anxiety (e.g. concerns about future outcomes). Thirdly, although our sample was recruited from a single school, the demographics of our sample were reflective of the UK population in terms of gender and ethnicity. Nonetheless, extension of this data to another adolescent sample would be valuable. Finally, this study did not include a non-imagery control so we cannot rule out the possibility that measuring ability to generate factual details of an event would produce the same pattern of results. However, this seems less likely given the opposite pattern of associations between depression and negative, compared to positive, imagery and so those who report higher depressive symptoms do not simply report lower vividness for events.

A final issue concerns the measure of life event severity/impact. The four levels in this measure (no, low, moderate and high impact) were initially assumed to be linear and analysed as such. This was due to several reasons. Firstly, commonly used life event measures (e.g. count of life events) are treated as linear so these studies assume each life event carries equal weighting and that the addition of each event is additive (e.g. Shapero et al., 2014). Some research has graded life events in terms of impact giving them a rating of one to five (e.g. Hazel, Hammen, Brennan, & Najman, 2008) and again assumes a linear relationship with depressive symptoms. Secondly, previous similar studies have adopted the approach of using ordinal data in this way (Meiser-Stedman et al., 2012) and statisticians suggest that ordinal data can be treated as continuous even if spacing is not equivalent (Pasta, 2009; Winship & Mare, 1984). Thirdly, although comparing the symptoms across these levels yielded mixed results and raised questions about whether equal spacing between the

levels could be assumed, the lack of statistical difference between the groups was most likely due to power [particularly due to the small sample size in the high impact/severity group (n=19)]. Nonetheless, the findings were replicated in analyses with life event coded as a binary variable by combining the no and low impact/severity groups and the moderate and high impact/severity groups.

Conclusion

Our findings demonstrate that, in adolescence, symptoms of depression are associated with having less vivid positive and more vivid negative mental imagery and vividness for images of positive future events moderated the relationship between negative life events and depression. These findings suggest novel approaches to strengthen interventions for adolescent depression and highlight the importance of considering positive prospective cognitions in the assessment and treatment of adolescent depression.

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Conflict of interest: Victoria Pile and Jennifer Lau declare that they have no conflict of interests.

Ethical approval: All procedures in the current study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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637 **Table 1:** Mean and standard deviations for intrusive image frequency, post-traumatic stress
638 symptoms, depression and anxiety for each life event rating.

Life event impact/severity	Intrusive image frequency	PTSS	Depression	Anxiety
No impact/severity (n=30)	NA	NA	5.065 (5.35)	17.592 (14.161)
Low impact/severity (n=204)	2.196 (1.917)	23.569 (14.584)	6.940 (5.388)	20.098 (12.463)
Moderate impact/severity (n=116)	2.517 (1.815)	29.001 (13.671)	9.023 (6.334)	24.165 (15.635)
High impact/severity (n=19)	3.632 (1.978)	32.790 (15.462)	11.742 (8.324)	30.035 (16.251)
Total sample	2.353 (1.924)	25.597 (14.908)	7.680 (5.993)	21.689 (14.114)

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642 **Table 2:** Means, standard deviations and correlations for the four imagery indices [for all
643 correlations, *r*(369)].

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	Mean (SD)	Positive Future	Negative Past	Negative Future
Positive Past	30.361 (3.710)	.650** 95% CI =.587 to .705	-0.034 95% CI = -.068 to .135	-0.088 95% CI = -.188 to .014
Positive Future	28.567 (4.584)		-0.069 95% CI = -.1135 to .068	0.031 95% CI = -.132 to .071
Negative Past	24.210 (5.122)			*r*(369) = .586** 95% CI =.51 to .66
Negative Future	21.106 (5.847)			

645 ** Correlation is significant at the .01 level.

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Table 3: Hierarchical regressions with depression score as the dependent variable and (1) past imagery and (2) future imagery.

DEPRESSION	***B***	**β**	***SE B***	***p***	**95% CI for *B***
Constant	3.330		2.892		
Gender	-1.330	-.111	.540	0.011	-2.379 to -.272
Age	.359	.078	.195	0.077	-0.034 to .751
Anxiety	.236	.556	.021	0.001	.193 to .276
Event severity	1.290	.150	.429	0.008	.480 to 2.147
STEP 2					
Gender	-1.144	-.095	.456	0.009	-2.058 to -.301
Age	0.170	.037	.171	0.332	-.168 to .506
Anxiety	0.151	.357	.025	0.001	.105 to .202
Event severity	0.865	.101	.366	0.020	.188 to 1.628
Positive Past	-0.559	-.345	.067	0.001	-.695 to -.431
Negative Past	0.317	.272	.059	0.001	.199 to .431
STEP 3					
Gender	-1.175	-.098	.451	0.007	-2.081 to -.316
Age	0.195	.042	.171	0.255	-.144 to .534
Anxiety	0.151	.355	.025	0.001	.104 to .201
Event severity	0.892	.104	.366	0.014	.220 to 1.682
Positive Past	-0.538	-.332	.067	0.001	-.672 to -.410
Negative Past	0.304	.260	.059	0.001	.182 to .420
Event severity x Positive Past	-0.401	-.070	.202	0.053	-.824 to -.001

DEPRESSION	***B***	**β**	***SE B***	***p***	**95% CI for *B***
Constant	3.330		2.713		
Gender	-1.330	-.111	.505	0.010	-2.363 to -.338
Age	.359	.078	.189	0.062	-0.003 to .752
Anxiety	.236	.556	.022	0.001	.194 to .275
Event severity	1.290	.150	.437	0.003	.447 to 2.119
STEP 2					
Gender	-1.357	-.113	.431	0.001	-2.227 to -.540
Age	0.233	.050	.171	0.159	-.080 to .592
Anxiety	0.175	.412	.021	0.001	.133 to .218
Event severity	0.967	.113	.368	0.007	.270 to 1.697
Positive future	-0.415	-.318	.059	0.001	-.535 to -.303
Negative future	0.291	.283	.043	0.001	.206 to .374
STEP 3					
Gender	-1.452	-.121	.425	0.001	-2.329 to -.630
Age	0.229	.050	.173	0.171	-.080 to .592
Anxiety	0.175	.414	.021	0.001	.135 to .218
Event severity	1.065	.124	.366	0.003	.375 to 1.784
Positive future	-0.387	-.297	.059	0.001	-.511 to -.284
Negative future	0.282	.274	.043	0.001	.199 to .368
Event severity x Positive future	-0.580	-.357	.253	0.017	-1.070 to -.096

651 Note: bootstrapped standard errors, p-vales and confidence intervals are reported.

652 **Table 4**: Hierarchical regressions with anxiety score as the dependent variable and (1) past
653 imagery and (2) future imagery.

ANXIETY	***B***	**β**	***SE B***	***p***	**95% CI for *B***
Constant	-.254		6.453		
Gender	7.765	.274	1.238	0.001	5.231 to 10.096
Age	-0.089	-.008	0.441	0.854	-0.970 to .726
Depression	1.232	.522	0.133	0.001	.988 to 1.494
Event severity	.780	.038	0.931	0.405	-1.090 to 2.566
STEP 2					
Gender	7.029	.248	1.205	0.001	4.567 to 9.231
Age	-0.147	-.013	0.436	0.741	-1.043 to 0.665
Depression	0.978	.414	0.153	0.001	0.674 to 1.279
Event severity	0.668	.033	0.906	0.468	-1.091 to 2.430
Positive past	-0.173	-.045	0.185	0.369	-0.546 to 0.156
Negative past	0.572	.207	0.121	0.001	0.351 to 0.818
STEP 3					
Gender	7.128	.252	1.211	0.001	4.645 to 9.388
Age	-0.111	-.010	0.437	0.797	-1.0054 to 0.691
Depression	0.975	.413	0.155	0.001	0.670 to 1.277
Event severity	0.585	.029	0.890	0.534	-1.141 to 2.343
Positive past	-0.117	-.031	0.188	0.563	-0.495 to 0.222
Negative past	.601	.218	0.121	0.001	0.375 to 0.849
Event severity x negative past	1.098	.540	0.620	0.071	0.10 to 2.414

654 Note: bootstrapped standard errors, p-vales and confidence intervals are reported.

	B	B	*SE B*	*p*	95% CI for *B*
ANXIETY					
Constant	-2.54		6.751		
Gender	7.765	.274	1.235	0.001	5.453 to 10.250
Age	-0.089	-.008	0.457	0.843	-0.949 to .801
Depression	1.232	.522	0.126	0.001	1.012 to 1.481
Event severity	.780	.038	0.942	0.407	-1.163 to 2.529
STEP 2					
Gender	7.699	.272	1.236	0.001	5.346 to 10.142
Age	-0.044	-.004	0.455	0.937	-0.930 to 0.868
Depression	1.169	.495	0.134	0.001	0.932 to 1.443
Event severity	0.861	.042	0.94	0.367	-1.040 to 2.594
Positive future	0.068	.022	0.153	0.641	-0.254 to 0.334
Negative future	0.211	.087	0.113	0.056	-0.017 to 0.419

Note: bootstrapped standard errors, p-vales and confidence intervals are reported.